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CENTRE FOR EFFECTIVE EDUCATION

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A Pilot Study of Reciprocal Peer Tutoring in Irish Medium Schools **Allen Thurston & Ciara Keenan (Queen's University Belfast)**

A Pilot Study of Reciprocal Peer Tutoring in Irish Medium Schools

Allen Thurston & Ciara Keenan (Queen's University Belfast)

Executive Summary

A pilot study to investigate the effects of mathematics peer tutoring in Irish medium primary schools was undertaken. Five schools and 90 students took part in the pilot. Materials and resources that had previously been shown to work in English medium Scottish schools were translated into Irish by CCEA. Irish medium teachers attended three professional development days. Teachers implemented the peer tutoring techniques during mathematics lessons during a period of 16 weeks. Changes in attainment were measured with an Irish translation of the Scottish Survey of Achievement Mathematics Test. Results were positive. Student attainment was significantly raised during the 16-week implementation period by over one standard deviation. This equated to one-year's worth of mathematics development during this time period. Results must be treated with caution. No control group was used in the pilot study. However, results are very promising and indicate that reciprocal role peer tutoring may be a useful pedagogy in Irish medium education. Further work would be required to establish this definitively.

Background

Theoretical Basis of Peer Tutoring

Piaget (1978) proposed that understanding developed in children through the processes of assimilation and accommodation, associated with the construction of internal schemas for understanding the world. Piagetian based peer tutoring can provide the right balance between the disequilibrium caused through cognitive challenge and social exchanges between peers for effective learning to take place (Palinscar, 1998). Piagetian tutoring involves cognitive challenge from peers and post-interactive reflection and restructuring. Both tutor and tutee have to fulfil their roles effectively. This creates a social interdependence between tutor and tutee. Their individual success is linked through common goals and mutual dependence on each other for gains in the tutoring process to accrue. Without both tutor and tutee performing their roles in accordance with prescribed patterns for interaction, neither can gain benefit from the interaction. Theories describing why social interdependence have been substantively developed and described by Social Interdependence Theory (Johnson, Johnson & Roseth, 2010; Johnson & Johnson 2012). For co-operative learning to be present during peer tutoring then social interdependence must be present in the form of:

- Goal structure (the pair work together with the aim of solving mathematics questions)
- Positive interdependence (in the tutoring process clear patterns for interaction are defined in the roles of tutor and tutee)
- Individual accountability (both the tutor and tutee have responsibilities, in the form of tutoring used each must reflect in their own performance and the performance of their peer partner)
- Interaction patterns (the tutoring process is structured to stimulate promotive interaction , group processing and enhance social skills)

Thurston and Topping (2006) developed a theoretical model of peer tutoring from De Lisi and Golbeck (1999). Students are set a problem. The tutor needs to examine the problem and think about what questions need to be asked during the interaction. The tutee needs to explain their thinking in solving a problem and answer questions posed by the tutor. Both of these processes require social interdependence (Johnson, Johnson & Roseth, 2010) and processing of prior knowledge using metacognitive strategy to link previous learning to the current problem. This also facilitates self-regulation should concomitantly result in enhanced metacognition as these two processes are interlinked (Eggen & Kauchak, 1997). This may facilitate assimilation of the learning and accommodation of new ideas. However, the accommodation does not imply long-term change at this point. Retaining the “correct” cognitive structure over time relies on the student gaining deeper understanding of the

new cognitive structures leading to equilibration as a result of post-interactive reflection.

Previous Studies and Research

Peer tutoring is a structured form of peer learning characterized by specific role taking as either tutor or tutee. It relies on constructivist approaches to learning and is based on the idea that knowledge acquisition occurs as a social activity (De Lisi & Golbeck, 1999). It is widely reported to have beneficial effects on learning (for example Ginsburgh-Block, Rohrbeck & Fantuzzo, 2006; Rohrbeck, Ginsburgh-Block, Fantuzzo & Miller, 2003; Topping, Kearney, McGee & Pugh, 2004). A meta-analytic review of peer learning reported large effect sizes for cognitive growth in mainstream elementary schools (Rohrbeck *et al.*, 2003). One of the more recently established forms of peer tutoring is reciprocal role peer tutoring. This form of peer tutoring means that each member of a dyad alternates in a role as peer tutor and tutee and is usually done with same-ability and often same-age tutorial pairs. Reciprocal peer tutoring was originally designed for pairs of low-achieving, urban, elementary school students (Fantuzzo, King & Heller, 1992). It employs dyads of comparable ability with the objective of keeping both tutor and tutee actively engaged with the academic process. Students receive training before engaging in peer learning. Dyads set joint goals and time-limits for achieving these goals. Reciprocal role tutoring has the advantage that both/all pupils get to act both as tutors and tutees. This has been shown to result in increased attainment gains when compared to interventions where pupils acted in a fixed tutor/tutee role (Chapman, 1998). Significant gains in spatial ability were reported in a sample of 214 eleven to sixteen-year-old pupils in a three month reciprocal role peer learning intervention (Gyanani & Pahuja, 1995). Reciprocal peer tutoring in mathematics was reported to have a positive impact on mathematical ability and student self-reported levels of maths ability when compared to control groups in a randomised trial of 64, nine-year-old pupils (Fantuzzo, King & Heller, 1992). Significant gains in mathematics were reported for a sample of 175 six to ten-year-old children for socio-economically disadvantaged children compared to control children in a class wide peer tutoring initiative (Greenwood, Delquadri & Hall, 1989). Training for peer tutors is essential. Experienced tutors were reported to use tutoring behaviours that prompted explanations from tutees, rather than just giving explanations. Enhanced tutoring was possible because of deeper metacognitive awareness of the problem (Fuchs, Fuchs, Bentz, Phillips & Hamlett, 1994). Undertaking peer tutoring with strategic metacognition was reported to enhance outcomes in a sample of 158, nine-year-old pupils in science (Meloth & Deering, 1994). Similar findings were reported in a study involving 384, fourteen-year-old pupils in mathematics. Significant advantages were reported for pupils who undertook data handling activities with peer

learning and an emphasis on strategic metacognition as compared to a control group (Kramarski & Mevarech, 2003). Therefore, reciprocal peer tutoring, combined with strategic metacognitive questioning can provide a strong mechanism for cognitive development.

The current study was based on two previous studies undertaken in Scotland and supported by the Economic & Social Research Council. In one cross-age peer tutoring was used in a 129 school randomised trial in Fife Local Education Authority. Using PIPS mathematics tests (delivered independently by Durham University then *Effect Sizes* of about 0.19 were reported for cross-age peer tutoring (Tymms, Merrell, Thurston *et al.*, 2011). The technique of peer tutoring was further developed in a study involving 20 schools in Stirlingshire, Falkirk and Dundee. In this study the tutoring method used in Fife was fine-tuned and adapted to a reciprocal role peer tutoring method. Using the Scottish Survey of Achievement Mathematics Test the study reported greater effects of Fife in the order of an *Effect Size* of 0.46 (Thurston, Burns & Topping, 2011; 2012).

Aims and Objective

The provenance of reciprocal role peer tutoring in English is therefore well established. However, that does not mean that it is a pedagogy that will generate similar gains in mathematics development in Irish medium mathematics lessons. The overall aim of this pilot study was to produce Irish medium versions of resources that have been shown to work in English medium schools in Scotland. In order to do this there was a requirement to undertake linguistic translation and examine the need for cultural adaptations to materials also. These materials were produced with a view to undertaking a small pilot study and ascertaining whether similar patterns of gains in mathematics would be replicated as had been observed in previous research in Scotland.

Research questions

What are the effects of peer tutoring on mathematics attainment in Irish medium primary schools and how do these compare to changes in mathematics attainment observed in English medium schools in previous historical studies in Scotland?

What sort of linguistic patterns appear when using peer tutoring in mathematics in Irish medium primary schools, how do these compare to similar use in English medium schools and how are they related to changes in attainment?

Method

Sample

Irish medium students: Data was collected from five Year 6 and Year 7 classes. Mean class size was 16.61 (range 7-21 students and *Standard Deviation* 4.02). Attainment data was collected from 90 students (41 male and 49 female). Mean age was 123.01 months (*Standard Deviation* 7.53).

Historical data from Scottish students: Data was collected from twenty Year 6 and Year 7 classes. Mean class size was 23.96 (range 8-33 students and *Standard Deviation* 4.25). Attainment data was collected from 451 students (237 male and 214 female). Mean age was 128.42 months (*Standard Deviation* 7.41).

Research instruments

Mathematics attainment: Criterion referenced attainment tests in mathematics were developed from tests used in The Scottish Assessment & Achievement Programme Survey-2004. This was a nationally available, independently designed instrument with good reliability and validity (Cronbach alpha values 0.7-0.9 in a sample of 2345, ten to twelve year-old Scottish students, Scottish Government (2004)). The instrument was scored out of 50. These were translated into Irish for use in Irish medium classes by CCEA.

Pupil talk: Detailed peer tutoring observations examined whether tutoring proceeded effectively and the extent to which metacognitive strategies were used during tutoring. Observations recorded and quantify the types of talk used by peer tutoring. Elements of talk indicative of metacognition were identified using adaptations of the techniques reported by Meloth and Deering (1994). Initial observations were conducted prior to the intervention being undertaken. Further observations were conducted during the intervention period (a three week period between the first and second maths topics). Pupils were observed together as they interacted in their tutor/tutee pair. Five one minute observation windows (10 seconds to locate, 30 seconds to observe, and 20 seconds to record) on 10 target pupils (5 pairs) from each class were undertaken. Observation schedules were similar to those previously reported to have good reliability by Thurston, Topping & Christie *et al.* (2008) ($\alpha=0.95$).

The following codes were used to describe what language was being used by students in Irish medium classes:

The unit of coding was a verbally explicit 'idea unit' (i.e. a single thematically coherent utterance). The researcher coded for each of the following speech patterns each time they occurred within an observation window:

TskD Task dimensions talk: pair tried to establish parameters of the task such that the task dimensions were identified and explained

Prop proposition: child suggests an idea or course of action (whether low or high level), or otherwise makes some form of statement that someone else could disagree with

Dis disagreement: child explicitly disagrees with a suggestion or explanation offered by another

Exp explanation: child offers an explanation of a proposition

Rfbk reference back: child explicitly refers back to a previous suggestion or explanation, irrespective of originator (i.e. they must refer to the content of the previous statement and point to the fact that this is something that has been said before – saying e.g. “I think the same” is not sufficient)

Res resolution/compromise: child acknowledges previous statement of other and adjusts own to include content (i.e. there must be some explicit fusion of ideas)

Inst instruction: child tells someone to say something or carry out some action

Ques question: child asks open-ended question (or gives other form of prompt) that directs attention to something not yet considered (e.g. “what about keeping weight the same?” “do you think it would make any difference if we used something solid?”); NB the key marker here is that this is a question that the asker does not want to know the answer to (they already know it)

UC uncodable / inaudible or not possible to classify as above

Continuing professional development: Teachers from selected schools attended three CPD days to train them in using peer tutoring techniques. Pupils spent one hour per week, for sixteen weeks on structured maths peer tutoring activities. Pupils undertake the role of peer tutor in one topic and peer tutee in the other.

Results

Maths attainment

Data collection and analysis was completed for five Irish medium pupils (81 pupils). Mean maths attainment score rose from 30.57 (*SD* 9.48) to 39.55 (*SD* 7.89). This represented a gain of 8.98 marks on the test. This gain was significant ($t=-6.90$, $df=50$, $p<0.0001$, *Effect Size*=1.0). Two-way ANOVA

indicated that gains were significantly greater for Irish medium students than had been observed in the historical Scottish sample ($F(2, 436)=0.17$, $p<0.0001$). Data for pre/post test scores for the Irish medium and historical Scottish samples is presented in Table 1.

Table 1: Mean pre-post test scores

Group name	N	Pre-test total (standard deviation)	Post-test total (standard deviation)	Effect Size
Irish medium students	81	30.57 (9.48)	39.55 (7.89)	1.00
Historical Scottish context	426	30.05 (10.13)	34.45 (9.1)	0.46

Observations

Observations were undertaken on 38 students during Irish medium maths lessons. Mean uses of the aspects of language on a two and a half minute observation period are presented in Table 2. Data from the historical Scottish sample is also presented. Data indicated very similar patterns of talk and dialog between pupils in English and Irish medium settings. Although slightly different means were reported for each, the differences between languages contexts never reached significance when analysed by ANOVA. This indicated that very similar patterns of talk and dialogue were driving the learning process. Of particular note is the high level of question use in the Irish medium students talk. This will be shown to be important later in the results section.

Links between talk and attainment outcomes

Observations were undertaken for 30 students whom had completed both pre and post tests. Multiple regression analysis explored the relationship between maths attainment gains and increase talk in Irish medium. A significant model emerged ($F(11,25)=4.85$, $p<0.001$). The model provided a very good fit for the data with an adjusted R^2 value of 0.63. Analysis indicated that talk in Irish about how pupils were going to approach a maths question (Task Dimensions) ($B=7.72$, $SEB=3.19$, $\beta=0.49$, $p<0.05$); how the question linked to prior work ($B=15.65$, $SEB=5.59$, $\beta=1.25$, $p<0.05$); disagreeing about an aspect of the work ($B=23.48$, $SEB=7.89$, $\beta=0.81$, $p<0.05$); and asking questions during work ($B=5.06$, $SEB=1.59$, $\beta=0.48$, $p<0.01$). In the historical context multiple

regress indicated that similar, but not identical, patterns of interaction were driving the learning process. In this context the significant model that emerged ($F(11, 168)=2.75, p<0.01$) indicated that the although the model was not a good fit and had an adjusted R^2 value of 0.10. However, in this context it was the asking of questions that predicted final mathematics attainment ($B=2.39, SEB=2.74, \beta=0.30, p<0.001$).

Table 2: Talk used by pairs during the two and a half minutes of observation windows when undertaking mathematics in Irish medium

Aspect of talk	Mean talk in Irish Medium (Std. Deviation)	Mean talk in historical Scottish context (Std. Deviation)
TskD	1.50 (0.60)	0.23 (0.50)
LO	0.39 (0.59)	0 (0)
OP	0.11 (0.31)	1.15 (0.87)
Link	0.42 (0.72)	0.05 (0.21)
Prop	1.34 (0.81)	2.77 (1.02)
Dis	0.08 (0.27)	0.35 (0.67)
Exp	1.16 (0.89)	1.19 (0.99)
Rfbk	0.58 (0.50)	0.02 (0.15)
Inst	0.42 (0.60)	0.44 (0.74)
Ques	2.03 (0.75)	1.18 (1.19)
Res	0.32 (0.57)	0.02 (0.15)

Discussion

Peer tutoring was demonstrated to be effective in the Irish medium setting. The experiment produced large Effect Size that were greater than those previously reported for the technique (Thurston *et al.*, 2012). There could be a number of reasons for this. The study was intensive in nature. Teachers changed their pedagogical approach for the duration of the study. There are risks of Hawthorne effects inherent in this. This is particularly true due to the attrition within the sample (on the presumption those completing post-tests

were more likely to have implemented with greater rigour). In addition there was no control group and so what may have happened without the intervention is not possible to predict. However, it should be noted that linguistic behaviours that were promoted and structured during the peer tutoring process namely, about how pupils were going to approach a maths question (Task Dimensions); how the question linked to prior work; disagreeing about an aspect of the work; and asking questions during work were found to predict post-test scores. Given this then there could be an argument made that these behaviours were contributing to academic success. Finally the *Effect Size* observed in this pilot was akin to the mathematics development that one may expect in a whole school year (Higgins, Kotosaki & Coe, 2011). Even if effects obtained in a controlled study would be anticipated to be lower than this, they may still produce significant gains after 'dilution'.

Implications for teachers are that time should be spent during mathematics lessons ensuring that the way in which students talk about mathematics is optimised. A meta-analysis of metacognition and learning identified that interventions that combined metacognition and mathematics could promote cognitive gains (Higgins, Hall, Baumfield & Moseley, 2005). Effect sizes tended to be larger when researcher devised tests were utilised and when sample sizes were smaller. The meta-analysis concluded that further research was required to ascertain which specific metacognitive approaches to learning were effective and explore the means by which these approaches had impact on learning. Findings indicated that developing strategic metacognitive awareness of how one would approach a mathematical question was central to successful learning. This was evidenced by the fact that enhanced levels of questioning predicted better post-test performance. It may follow that having to answer questions posed by the tutor, may promote enhanced strategic self-regulation, as the work approach had been verbalised and defined and could be regulated. Results indicated that there was evidence to support this. The fact that talk behaviours in respect of how pupils were going to approach a maths question; how the question linked to prior work; disagreeing about an aspect of the work; and asking questions during work predicted post-test scores in mathematics.

Further work could include a larger study that would control for 'treatment as usual'. In addition such a study could map interaction patterns further and try to link these to academic outcomes in a larger sample. This may help establish the main effect on outcomes. If such studies demonstrated that large effects persist, then Irish medium schools may wish to review whether current pedagogies maximise potential of students in school and use reciprocal peer tutoring as a tool in their professional practice.

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